



PCT/ZA 2002/00024

# Sertifikaat

REPUBLIEK VAN SUID AFRIKA

PATENT KANTOOR  
DEPARTEMENT VAN HANDEL  
EN NYWERHEID

# Certificate

REPUBLIC OF SOUTH AFRICA

PATENT OFFICE  
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Hiermee word gesertifiseer dat  
This is to certify that

the documents annexed hereto are true copies of:

PCT Application No. PCT/ZA02/00024 filed with the South African  
Receiving Office on 06 March 2002 in the name of BILLITON  
SA LIMITED for an invention entitled: "RECOVERY OF METALS FROM  
JAROSITE-CONTAINING MATERIALS"

CERTIFIED COPY OF  
PRIORITY DOCUMENT

Geteken te  
signed at  
**PRETORIA**

in die Republiek van Suid-Afrika, hierdie  
in the Republic of South Africa, this

dag van  
day of  
4 March 2005

Registrar of Patents

## PCT REQUEST

INT1046/MAJR

Original (for SUBMISSION) - printed on 05.03.2002 09:05:53 AM

0	For receiving Office use only	
0-1	International Application No.	PCT/ZA92/00024
0-2	International Filing Date	06 MAR 2002
0-3	Name of receiving Office and "PCT International Application"	SAPTO
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	South African Patents and Trade Marks Office (RO/ZA)
0-7	Applicant's or agent's file reference	INT1046/MAJR
I	Title of invention	RECOVERY OF METALS FROM JAROSITE-CONTAINING MATERIALS
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	BILLITON SA LIMITED
II-5	Address:	200 Hans Strijdom Drive 2194 Randburg South Africa
II-6	State of nationality	ZA
II-7	State of residence	ZA
II-8	Telephone No.	+27 11 792-7090
II-9	Facsimile No.	+27 11 792-7097
III-1	Applicant and/or inventor	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	AHERN, Noelene
III-1-5	Address:	c/o 200 Hans Strijdom Drive Randburg 2194 South Africa South Africa
III-1-6	State of nationality	ZA
III-1-7	State of residence	ZA

 REGISTRAR OF PATENTS DESIGNS,  
TRADE MARKS AND COPYRIGHT

2002-03-06

 REGISTRATEUR VAN PATENTE, MODELLE,  
HANDELSMERKE EN OUTEURSREG

## PCT REQUEST

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III-2	<b>Applicant and/or inventor</b>	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	SCHAEKERS, Jozef, Marie
III-2-5	Address:	c/o 200 Hans Strijdom Drive Randburg 2194 South Africa South Africa
III-2-6	State of nationality	ZA
III-2-7	State of residence	ZA
IV-1	<b>Agent or common representative; or address for correspondence</b> The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	MCCALLUM RADEMEYER & FREIMOND
IV-1-2	Address:	PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
IV-1-3	Telephone No.	+27 11 789-1046
IV-1-4	Facsimile No.	+27 11 787-4516
IV-2	<b>Additional agent(s)</b>	agent
IV-2-1	Name (LAST, First)	RADEMEYER, Montague, Ampie, John
IV-2-2	Address:	PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
IV-2-3	Telephone No.	+27 11 789-1046
IV-2-4	Facsimile No.	+27 11 787-4516

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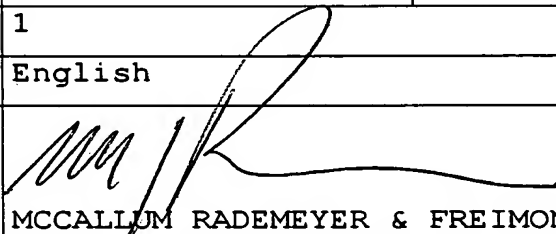
Original (for SUBMISSION) - printed on 05.03.2002 09:05:53 AM

V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	<p>AP: GH GM, KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT</p> <p>EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT</p> <p>EP: AT BE CH&amp;LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE TR and any other State which is a Contracting State of the European Patent Convention and of the PCT</p> <p>OA: BF BJ CF CG CI CM GA GN GQ GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT</p>
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	<p>AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH&amp;LI CN CO CR CU CZ DE DK DM DZ EC EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PH PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW</p>
V-5	Precautionary Designation Statement  In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	08 March 2001 (08.03.2001)
VI-1-2	Number	2001/1927
VI-1-3	Country	ZA
VII-1	International Searching Authority Chosen	European Patent Office (EPO) (ISA/EP)

## PCT REQUEST

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<b>VIII</b>	<b>Declarations</b>	<b>Number of declarations</b>	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
<b>IX</b>	<b>Check list</b>	<b>number of sheets</b>	<b>electronic file(s) attached</b>
IX-1	Request (including declaration sheets)	5	-
IX-2	Description	11	-
IX-3	Claims	3	-
IX-4	Abstract	1	EZABST00.TXT
IX-5	Drawings	1	-
IX-7	TOTAL	21	
	<b>Accompanying items</b>	<b>paper document(s) attached</b>	<b>electronic file(s) attached</b>
IX-8	Fee calculation sheet	✓	-
IX-10	Original general power of attorney	✓	-
IX-10	Original general power of attorney	✓	-
IX-10	Original general power of attorney	✓	-
IX-17	PCT-EASY diskette	-	Diskette
IX-19	Figure of the drawings which should accompany the abstract	1	
IX-20	Language of filing of the international application	English	
X-1	Signature of applicant, agent or common representative		
X-1-1	Name	MCCALLUM RADEMEYER & FREIMOND	
X-1-2	Name of signatory	MAJ Rademeyer	
X-1-3	Capacity	Agent	

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	06 MAR 2002
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	

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10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/EP
10-6	Transmittal of search copy delayed until search fee is paid	

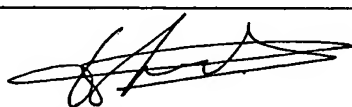
## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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## PCT POWER OF ATTORNEY

INT1046/MAJR


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0-1	PCT Power of Attorney (for an international application filed under the Patent Cooperation Treaty) (PCT Rule 90.4)	
0-1-1	Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
1	The undersigned applicant(s)	SCHAEKERS, Jozef, Marie
1-1-1	hereby appoints (appoint) the following person	MCCALLUM RADEMEYER & FREIMOND PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
1-1-2	hereby appoints (appoint) the following person	RADEMEYER, Montague, Ampie, John PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
1-2	as	agent
1-3	to represent the undersigned before	all the competent International Authorities
1-4	in connection with the international application identified below:	
1-4-1	Title of the invention	RECOVERY OF METALS FROM JAROSITE-CONTAINING MATERIALS
1-4-2	Applicant's or agent's file reference	INT1046/MAJR
1-4-3	International application number (if already available)	
1-4-4	filed with the following Office as receiving Office	South African Patents and Trade Marks Office (RO/ZA)
1-5	and to make or receive payments on behalf of the undersigned.	
2-3	Signature of applicant	
2-3-1	Name	SCHAEKERS, Jozef, Marie
3	Date	22 January 2002 (22.01.2002)

## PCT POWER OF ATTORNEY

INT1046/MAJR

Printed on 22.01.2002 08:46:45 AM

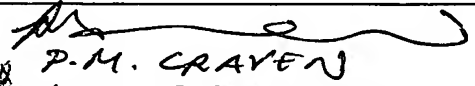
0-1	PCT Power of Attorney (for an international application filed under the Patent Cooperation Treaty) (PCT Rule 90.4)	
0-1-1	Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
1	The undersigned applicant(s)	AHERN, Noelene
1-1-1	hereby appoints (appoint) the following person	MCCALLUM RADEMEYER & FREIMOND PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
1-1-2	hereby appoints (appoint) the following person	RADEMEYER, Montague, Ampie, John PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
1-2	as	agent
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1-4-3	International application number (if already available)	
1-4-4	filed with the following Office as receiving Office	South African Patents and Trade Marks Office (RO/ZA)
1-5	and to make or receive payments on behalf of the undersigned.	
2-2	Signature of applicant	
2-2-1	Name	AHERN, Noelene
3	Date	22 January 2002 (22.01.2002)



## PCT POWER OF ATTORNEY

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0-1	PCT Power of Attorney (for an international application filed under the Patent Cooperation Treaty) (PCT Rule 90.4)	
0-1-1	Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
1	The undersigned applicant(s)	BILLITON SA LIMITED
1-1-1	hereby appoints (appoint) the following person	MCCALLUM RADEMEYER & FREIMOND PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
1-1-2	hereby appoints (appoint) the following person	RADEMEYER, Montague, Ampie, John PO Box 1130 7 Maclyn House Bordeaux 2125 Randburg South Africa
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1-4-1	Title of the invention	RECOVERY OF METALS FROM JAROSITE-CONTAINING MATERIALS
1-4-2	Applicant's or agent's file reference	INT1046/MAJR
1-4-3	International application number (if already available)	
1-4-4	filed with the following Office as receiving Office	South African Patents and Trade Marks Office (RO/ZA)
1-5	and to make or receive payments on behalf of the undersigned.	
2-1	Signature of applicant	
2-1-1	Name	P.M. CRAVEN VICE PRESIDENT - TECHNOLOGY BILLITON SA LIMITED
3	Date	22 January 2002 (22.01.2002)

## PCT (ANNEX - FEE CALCULATION SHEET)

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(This sheet is not part of and does not count as a sheet of the international application)

0	For receiving Office use only	
0-1	International Application No.	
0-2	Date stamp of the receiving Office	06 MAR 2002
0-4	Form - PCT/RO/101 (Annex) PCT Fee Calculation Sheet Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
0-9	Applicant's or agent's file reference	INT1046/MAJR
2	Applicant	BILLITON SA LIMITED, et al.
12	Calculation of prescribed fees	fee amount/multiplier      total amounts (ZAR)
12-1	Transmittal fee      T	⇒      500
12-2	Search fee      S	⇒      7,220
12-3	International fee	
	Basic fee	
	(first 30 sheets)      b1	3,152
12-4	Remaining sheets	0
12-5	Additional amount      (X)	72
12-6	Total additional amount      b2	0
12-7	b1 + b2 =      B	3,152
12-8	Designation fees	
	Number of designations contained in international application	90
12-9	Number of designation fees payable (maximum 6)	6
12-10	Amount of designation fee      (X)	680
12-11	Total designation fees      D	4,080
12-12	PCT-EASY fee reduction      R	-972
12-13	Total International fee (B+D-R)      I	⇒      6,260
12-17	TOTAL FEES PAYABLE (T+S+I+P)	⇒      13,980
12-19	Mode of payment	cheque

## VALIDATION LOG AND REMARKS

13-2-7	Validation messages Contents	Green? Priority 1. The priority document is not enclosed. (The applicant must furnish it within 16 months from the earliest priority date claimed)
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## RECOVERY OF METALS FROM JAROSITE-CONTAINING MATERIALS

### BACKGROUND OF THE INVENTION

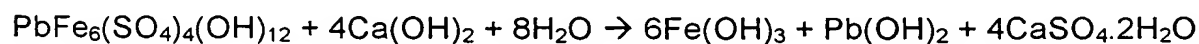
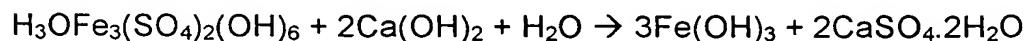
This invention relates to the recovery of metals from jarosite-containing materials.

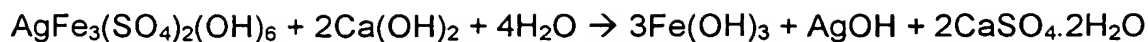
The leaching of certain metals. e.g. silver (Ag), lead (Pb) and zinc (Zn) using brine leaching, is well known.<sup>(1,2,3,4,5)</sup> The ease of solubilising these metals depends on the refractory nature of the material treated.

To improve recoveries from refractory materials by brine leaching, a combined high temperature oxidation process in combination with acidic brine leaching has been proposed.<sup>(4)</sup> A concentrate containing silver, mostly in sulfide minerals, yielded only 50 % Ag dissolution in a FeCl<sub>3</sub> brine leach. By leaching the concentrate at temperatures above 100°C with a high oxygen partial pressure in an acidic NaCl or CaCl<sub>2</sub> medium, the Ag recovery was increased to above 95 %.

Brine leaching alone is not effective in solubilising metals included in or encapsulated by jarosite or other similar iron hydroxy sulfate compounds since these compounds must first be decomposed.

Decomposition of jarosites in alkaline media is well known. Jarosites produced during pressure leaching of zinc concentrates were decomposed by treating the residues with a lime slurry at 90°C.<sup>(7)</sup> The following reactions were proposed to describe the reactions for hydronium jarosite, plumbojarosite and argentojarosite respectively:





After liberation, Ag was subsequently recoverable by cyanidation.<sup>(7)</sup>

Destruction of jarosites produced in pressure leaching at 85°C to 90°C using an approximately stoichiometric quantity of lime, followed by cyanidation, improved Ag recoveries from less than 5 % to more than 97 %.<sup>(9)</sup>

NaOH has also been used to facilitate alkaline decomposition of jarosite-type materials before cyanidation.<sup>(8)</sup>

Leaching of jarosite-containing materials in an acidic brine medium of  $\text{CaCl}_2$  at a temperature above the boiling point of the solution and elevated pressures, in the presence of lime or another suitable alkali to maintain the pH between 1.5 and 3.5, has been proposed to recover metals from jarosite.<sup>(6)</sup> Although this method was successful to recover Ag and Pb from jarosites the use of high pressures and temperatures is not always desirable.

It seems obvious that if metal recovery from jarosites is required, an alkaline pretreatment followed by cyanidation is a generally accepted and suitable method. However, cyanide has environmental disadvantages, and in some cases, cyanide consumption is too high for such a process to be economical, particularly in the presence of base metals like Cu, and sulfides.

Also, it is implied that jarosite-containing materials can be pretreated in an alkaline medium to liberate certain metals and that, once the metals are in suitable forms, brine leaching can be used to solubilise them. However, this treatment implies the use of a liquid/solid separation step between the alkaline decomposition stage and

the acidic brine solubilisation, and additional process steps and costs. There would be advantages to eliminating this liquid/solid separation, by carrying out the alkaline decomposition in a brine medium followed immediately by acidification to solubilise the required metals. Also, the alkaline decomposition step is shown to be facilitated in a brine solution.

### SUMMARY OF INVENTION

The invention provides a method to dissolve at least one metal from jarosite or other iron hydroxy sulfate-containing material which includes the steps of:

- a) subjecting the material to alkaline treatment in a brine solution to facilitate jarosite decomposition, and
- b) acidification of the brine slurry to solubilise the liberated metal.

The method may include the step of adjusting the pH of the brine slurry to remove solubilised iron or other impurities from the slurry followed by the step of separating metal-containing brine solution and solid residue from each other.

The metal value or values can be removed from the brine solution by any appropriate means selected, for example, from: cementation, ion exchange, solvent extraction, electrowinning and precipitation. After metal recovery, the barren brine liquor may be recycled to the alkaline treatment stage. A bleed stream may be introduced to control impurities, and additional NaCl and water may be added on recycle to compensate for any losses.

Preferably the temperature in the alkaline treatment stage is between 30°C and 100°C.

Alkali may added to the brine solution in the form of lime, NaOH, LiOH or any other suitable alkali, or any combination thereof.

Preferably the brine concentration is between 100 g/l NaCl and saturation levels, or the equivalent of any other soluble chloride salt.

5 The temperature in the acidic brine leach stage may be between 30°C and 100°C.

The pH of the acidic brine leach stage is preferably less than 6.

The method may be used particularly for the recovery of silver.

#### BRIEF DESCRIPTION OF THE DRAWING

10 The invention is further described by way of examples with reference to the accompanying drawing which is a flow chart representation of the method of the invention.

#### DESCRIPTION OF PREFERRED EMBODIMENT

15 Referring to the accompanying drawing, a silver and jarosite-containing residue (10) is typically obtained by subjecting a silver-bearing material to a leaching process (e.g. bioleaching or pressure leaching) or by subjecting a silver and iron containing liquor to a precipitation process (e.g. iron removal).

20 The residue is subjected to an alkaline pretreatment in a brine medium (12). The liquid to solid ratio should be sufficient to ensure ease of operation and to ensure that no solubility constraints exist for the silver. The brine solution or slurry should contain from 100 g/l NaCl to saturation levels, preferably 200 g/l to 300 g/l. The

brine solution may contain various impurities, including sulfate. Sulfate levels of up to 10 g/l may be acceptable, but less than 5 g/l are expected if lime is used as the alkali. The slurry should be maintained at a temperature of 30°C to 100°C, preferably 50°C – 90°C.

5 An alkali (14), such as lime, is added to the slurry either to maintain an alkaline pH (>7), preferably greater than or equal to 9, and less than 13, or at a fixed addition rate based on the stoichiometry of the alkaline decomposition reaction.

10 The reaction is allowed to continue for a time depending on the composition of the material and the reaction temperature and pH. Usually a few hours are sufficient but more than 24 hours may be required in some cases, particularly in the lower pH or temperature ranges.

15 The alkaline brine slurry is then acidified (step 16), without any intermediate liquid/solid separation, by the addition of any suitable acid (18), preferably HCl or H<sub>2</sub>SO<sub>4</sub>, to a pH most suitable for the metal that is to be dissolved. For Ag, the pH should be greater than 0.1 and less than 6, preferably between 1 and 3.

The temperature of the acidic brine leach can be the same as that used in the alkaline pretreatment step (30°C – 100°C) and is preferably 70°C - 90°C.

As for the alkaline pretreatment stage, the residence time required for the acid leaching stage is variable, but is not expected to be longer than 8 hours.

20 An iron removal stage 20 may be included where the pH of the slurry is increased slightly by the addition of a suitable alkali 22, to precipitate iron. The pH should be less than 5.

After liquid/solid separation (24) to remove the solid residue 26, Ag is recovered by any suitable means, in this case, cementation 28 with Fe scrap 30. The Ag product is removed by liquid/solid separation (34) and the barren brine solution 36 is recycled to the alkaline pretreatment step (12).

- 5 Part of the brine solution 36 may be removed as a bleed stream 38 to control impurity build up. Also it may be necessary to add NaCl (40) and water 42 to make up the stream recycled to the stage 12.

### Example 1

10 A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at 80°C at a liquid to solid ratio of 10:1. The natural pH of the slurry ranged between 1.8 and 2.4. After leaching for 6 hours, the Ag dissolution was 22%.

This indicates that brine leaching alone is not sufficient to recover Ag from jarosite-type materials.

### Example 2

15 A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at 70 °C at a liquid to solid ratio of about 7:1. Lime was added as a slurry to 145 kg Ca(OH)<sub>2</sub> per ton of sample, based on a stoichiometric excess of 20 %, and the slurry was agitated for 2 hours. The slurry was then acidified to pH 2 by  
20 adding 97 kg H<sub>2</sub>SO<sub>4</sub> per ton of sample, and agitated for a further 5 hours. Ag dissolution of 94 % was obtained.



This illustrates the process of the invention using a fixed amount of alkali.

### Example 3

5 A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at 80°C at a liquid to solid ratio of about 7:1. Lime was added as a slurry to maintain a constant pH of 9. After 3 hours, 126 kg  $\text{Ca(OH)}_2$  per ton of sample had been consumed. The slurry was then acidified to pH 2 by adding 87 kg  $\text{H}_2\text{SO}_4$  per ton of sample and allowed to react for a further 5 hours. Ag dissolution of 93% was achieved.

10 This illustrates the process of the invention using a set pH during the alkali treatment.

### Example 4

15 A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at 70°C at a liquid to solid ratio of about 7:1. Lime was added as a slurry to maintain a constant pH of 9.5. After 4 hours, 181 kg  $\text{Ca(OH)}_2$  per ton of sample had been consumed. The slurry was then acidified to pH 2 by adding 100 kg  $\text{H}_2\text{SO}_4$  per ton of sample and allowed to react for a further 5 hours. Ag dissolution of 94% was achieved.

20 This test was repeated, but excluding brine from the alkaline decomposition stage. After 24 hours, 83 kg  $\text{Ca(OH)}_2$  per ton of sample had been consumed. The slurry was then acidified by adding 54 kg  $\text{H}_2\text{SO}_4$  per ton of sample and allowed to react for a further 5 hours. Ag dissolution of 43% was achieved.

This illustrates that the presence of brine in the alkaline decomposition stage facilitates the decomposition of jarosite.

### **Example 5**

5 A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at 70°C at a liquid to solid ratio of about 7:1. Lime was added as a slurry to 145 kg Ca(OH)<sub>2</sub> per ton of sample, based on a stoichiometric excess of 20%, and the slurry was agitated for 2 hours. The slurry was then acidified to pH 2 by adding 131 kg H<sub>2</sub>SO<sub>4</sub> per ton of sample, and agitated for a further 5 hours.

10 To remove Fe from the circuit, limestone was added as a solid to establish a pH of 3.7. The solid residue was then separated from the brine solution. Overall Ag dissolution of 87% was obtained.

This illustrates the process of the invention when an iron removal stage is included.

### **Example 6**

15 The same procedure was carried out as for example 2, except that the temperature during alkaline pretreatment was 50°C, not 70°C. Acid consumption in the acid leach step was 164 kg H<sub>2</sub>SO<sub>4</sub> per ton, and Ag dissolution was only 63%.

20 This example illustrates the importance of temperature in the alkaline treatment stage.

**Example 7**

A residue containing about 70% of Ag in jarosite was slurried with a 260 g/l NaCl solution at (a) 70°C and (b) 80°C at a liquid to solid ratio of about 7:1. Lime was added as a slurry to maintain a constant pH of 9 for both tests, and the slurry was agitated until no further lime additions were necessary to maintain the set pH. The slurries were then acidified to pH 2 by adding (a) 82 and (b) 87 kg H<sub>2</sub>SO<sub>4</sub> per ton of sample respectively, and agitated for a further 5 hours.

In both cases, Ag dissolution was 93%. However, where the alkali treatment was done at 70°C, 7.5 hours were required to complete this stage, while at 80°C, only 3 hours were required.

This example illustrates the effect of temperature and time on the proposed process.

CLAIMS:

1. A method to dissolve at least one metal from jarosite or other iron hydroxy sulfate containing-material which includes the steps of:
  - (c) subjecting the material to alkaline treatment in a brine solution to facilitate jarosite decomposition, and
  - (d) acidification of the brine slurry to solubilise the liberated metal.
2. A method according to claim 1 which includes the step of adjusting the pH of the brine slurry to remove solubilised iron or other impurities from the slurry followed by the step of separating metal-containing brine solution and solid residue from each other.
3. A method according to claim 2 which includes the step of removing metal value or values from the brine solution using a technique selected from: cementation, ion exchange, solvent extraction, electrowinning and precipitation.
4. A method according to claim 3 wherein, after the step of removing the metal value or values, barren brine liquor is recycled for use in the alkaline treatment (step (a)).
5. A method according to claim 4 which includes the steps of bleeding impurities from the barren brine liquor and adding NaCl and water to the barren brine liquor prior to the alkaline treatment.
6. A method according to any one of claims 1 to 5 wherein the temperature in the alkaline treatment stage is between 30°C and 100°C.

7. A method according to claim 6 wherein the temperature in the alkaline treatment stage is between 50°C to 90°C.
8. A method according to any one of claims 1 to 7 wherein the brine concentration of the brine solution is between 100g/l NaCl and saturation levels, or the equivalent of any other soluble chloride salt.
9. A method according to claim 8 wherein the brine concentration of the brine solution is between 200g/l and 300g/l NaCl.
10. A method according to any one of claims 1 to 9 wherein the temperature of the brine slurry during step (b) is between 30°C and 100°C.
11. A method according to claim 10 wherein the temperature of the brine slurry during step (b) is between 50°C and 90°C.
12. A method according to any one of claims 1 to 11 wherein the pH of the brine slurry during step (a) is above 7.
13. A method according to claim 12 wherein the pH of the brine slurry during step (a) is between 9 and 13.
14. A method according to any one of claims 1 to 13 wherein the pH of the brine slurry during step (b) is less than 6.
15. A method according to claim 14 wherein the pH of the brine slurry during step (a) is between 1 and 3.

16. A method according to any one of claims 1 to 15 wherein the temperature of the slurry during step (b) is between 30°C and 100°C.

17. A method according to claim 16 wherein the temperature of the slurry during step (b) is between 70°C and 90°C.

5 18. A method according to any one of claims 1 to 17 wherein the duration of step (a) is less than 24 hours.

19. A method according to any one of claims 1 to 18 wherein the duration of step (b) is less than 8 hours.

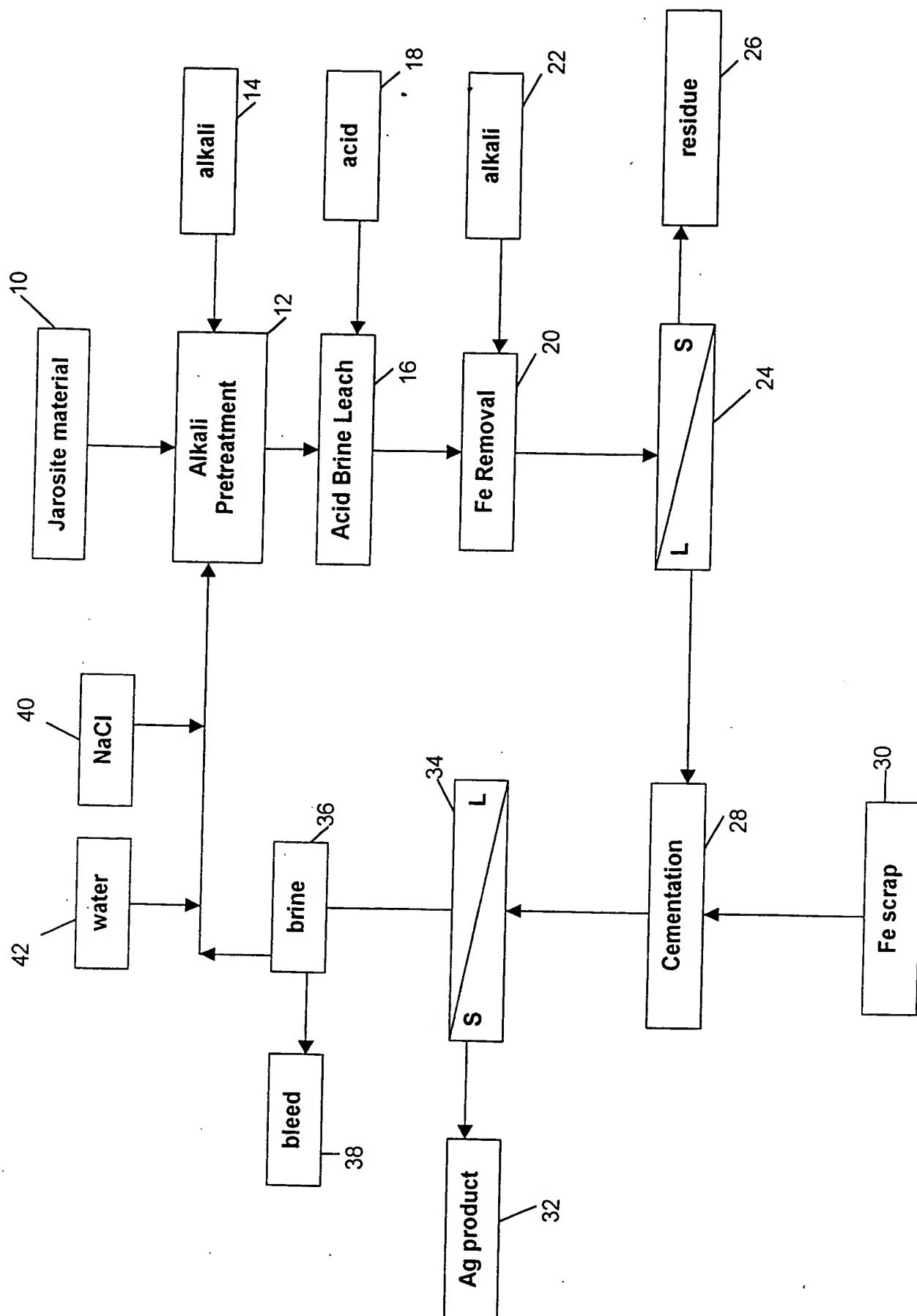
10 20. A method according to any one of claims 1 to 19 wherein at least one metal is silver.

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ABSTRACT

A method to dissolve at least one metal from jarosite or other iron hydroxy sulfate containing-material which includes the steps of subjecting the material to alkaline treatment in a brine solution to facilitate jarosite decomposition, and acidification of the brine slurry to solubilise the liberated metal.

(Fig. 1)